with either cylinder wire, were surrounded by brass tubes connected with the earth. The sensitiveness of the electrometer was such as to produce for a ΔV of 0·01 V, a shifting of about 7 mm. on the scale. The connection of the cylinder wires with the earth was brought about by touching them with brass wires connected with the earth. In the whole there was not on the path from the cylinder wire to the electrometer any contact of two different metals. The cylinder was charged, as a rule, to 100 V by a battery of storage cells.

During the progress of these experiments a very interesting phenomenon presented itself. It was found that when either of the cylinders is connected with the earth, the wire enclosed within it, after being disconnected from the earth, immediately begins to get electrified, *i.e.* the electrometer thereupon indicates a rise of a potential, which continually increases during a certain interval of time, some hours in the main, before reaching a limiting value. (The electrification was observed when the mud was removed from the cylinders.) The wire contained in the zinc cylinder becomes positively electrified, whilst that in the brass cylinder becomes negatively electrified. Having remarked such a phenomenon, we introduced into the brass cylinder which opened from beneath, a zinc cylinder, placed coaxially so as to enclose the wire. This cylinder was in metallic connection with the surrounding brass one. In this case, too, the wire acquired a potential, but it was opposite in sign to that it acquired without such a zinc cylinder being merely enclosed in the brass cylinder, *i.e.* it became positively electrified. The maximum value of the potential produced in the wire amounted in our observations to 0·2 V. This maximum value depends, it seems, upon the degree of ionisation of the air in the cylinder.

We also replaced the zinc cylinder at the interior of the great brass cylinder by others of lead, aluminium, iron and silver, with the effect that the two former acted in the same direction as the zinc cylinder; the lead cylinder, which, by the bye, proved very radio-active, gave the strongest effect (about 0·35 V), whilst aluminium took the last place, zinc remaining in the middle. The iron and the silver cylinders, on the contrary, exerted the same action as the main brass cylinder, giving a negative electrification, but to a less degree.

The phenomenon we have observed seems to be in correspondence with effects produced in metals by air ionised with Röntgen rays (I. Borgmann and A. Gerchun, *C. R.*, cxxii. p. 378, 1896; Minchin, the *Electrician*, March 27, 1896; Rutherford, *Phil. Mag.*, xliii. p. 241, 1897). It may perhaps give the explanation of atmospheric electricity; and it is also of interest in the fact that here we take electrical energy directly from the air. I. BORGMANN.

Physical Institute, The University, St. Petersburg, May 9.

Graphic Methods in an Educational Course on Mechanics.

IT is difficult to reconcile Mr. Milne's opening statement (NATURE, May 5, p. 5) with the rest of his letter. He begins by venturing to think that no one will gainsay Mr. W. Larden's main contention (NATURE, April 28, p. 607) that "analytical methods give a grasp of the principles of statics while graphical methods disguise them," and he goes on to give half a dozen instances confuting it. Mr. Larden wrote to elicit opinions from those who have taught mechanics, and as I have had only one pupil, a very troublesome one, namely, myself, I cannot think that my opinions are invited. But when Mr. Milne thinks that no one will gainsay the contention, the challenge is a wide one, and I deny it emphatically, and know that there are hundreds of men who will agree with me. These men are not teachers or mathematicians, but those who have to use mathematics for their profession or trade.

I have the highest admiration for all those to whom science is an end in itself. I fully appreciate the attitude of mind (the butt of so many jokes) which feels that mathematics and other sciences become degraded by useful applications. But for one true mathematician there are a thousand men to whom mathematics are but a means to an end. Many of these, like myself, are not mathematically minded (as Mr. Larden probably counts mathematics), and with the exception of Maxwell's "reciprocal figures" and a few others, we have had to work out graphical methods mainly for ourselves. Teachers are now coming round, or as Mr. Larden would put it, giving way, or as I would put it, waking up, and are recognising that analytical language, powerful as it is for research, is not paramount for explanation. "I believe," wrote Prof. J. Perry in his "Spinning Tops," "that there are very few mathematical explanations of phenomena which may not be given in quite ordinary language to people who have an ordinary amount of experience. In most cases the symbolical algebraic expression must be given first by somebody, and then comes the time for its translation into ordinary language."

I agree with the whole of Mr. Milne's letter except the first few words, and, like him, "I believe the best results will be obtained when the two methods are used side by side." Of my own acquaintances, about one in five prefer analytical methods, but the others have a diagram in their heads, if not before them on paper as a guide to bring it vividly before the mind (to borrow Mr. Larden's words). Mr. Larden concludes, "graphical work consumes an amount of time that seems out of proportion to the mental training and knowledge of principles gained." The title of his letter shows that he has "an educational course" in view, and *qua* education, "mental training and knowledge of principles" is the true and only object. His pupils should emerge as mathematicians. But those who have to use statics professionally would not hesitate to consume twice or thrice the time on a graphical method if it carries conviction of truth with it, as it does to two or three at least out of five of my acquaintances.

Mr. Larden dates his letter from Devonport, and this suggests that some of his pupils hope to become naval officers and not wranglers; that mathematics will be used by them in after life as a means to an end. Would he deny the use of a piece of string on a globe to explain "great circle sailing," or does he use a formula applicable generally to figures of revolution, of which the earth and Saturn's ring are particular cases? Sumner's method may be disguised in algebra, but it must be confessed that the famous "line" as discovered by him was a bit of pure graphics.

It may be impossible for Mr. Larden to appreciate the geometrical point of view, for my contentions are exactly the opposite of his first and fourth. For us non-mathematicians, "graphical methods give a grasp of the principles of statics, while analytical methods disguise them," and "analytical methods confuse learners of statics." The second contention, "Analytical methods must be mastered in any case," needs the addition of the words "by the help of diagrams." If there be any truth in the third contention, that "analytical methods connect statics with dynamics," it is of small importance if they fail to elucidate dynamics. Nature herself gainsays these contentions with the parabola of the fountain, the ripple of the pond, and the slope of the sand hill.

A. P. TROTTER.

8 Richmond Terrace, Whitehall, S.W., May 13.

ANY educational course in mechanics should undoubtedly be based first of all on experiment. If such is the case, it is practically impossible for any student using "graphical methods" to make the wild "shots" referred to by Mr. Larden (vol. lxix. p. 607), who seems to have been very unfortunate in the kind of boy he has received from "a preparatory school"; or is it the boy who has been unfortunate in his previous training? Has Mr. Larden considered the possibility of the "method of teaching" adopted being wrong in the aforesaid school? Surely there is no inherent quality in "graphical methods" to cause these wildest of "shots." The writer's experience goes entirely against this idea, and supports the contentions set forth by Mr. Milne.

Mr. Larden writes:—"If then, there be not time for both, it is the latter (Graphics) that should be sacrificed." If time is so short that some sacrifice must be made, the

writer is of opinion that it would be better to take a less comprehensive course than to omit "graphical methods" entirely.

The best method for mechanics, as for all physical sciences, is :—

(1) Experimental work to be carried out by the boys.

(2) Consideration of, discussion on, and deduction from the experimental data obtained by the boys, with an occasional demonstration by the teacher to clench any particular point. This treatment of the experimental work to involve both analytical and *graphical* methods.

In fact, a truly educational course in mechanics is impossible without experimental work. Granted this experimental work, the writer is of opinion that the aim of the students will be considerably improved, and not only so, but there will be a complete absence of wild "shots."

S. IRWIN CROOKES.

Secondary and Technical School Clay Cross, Chesterfield, May 15.

EUGENICS; ITS DEFINITION, SCOPE AND AIMS.[1]

EUGENICS is the science which deals with all influences that improve and develop the inborn qualities of a race. But what is meant by improvement? We must leave morals as far as possible out of the discussion on account of the almost hopeless difficulties they raise as to whether a character as a whole is good or bad. The essentials of eugenics may, however, be easily defined. All would agree that it was better to be healthy than sick, vigorous than weak, well fitted than ill fitted for their part in life. In short, that it was better to be good rather than bad specimens of their kind, whatever that kind might be. There are a vast number of conflicting ideals, of alternative characters, of incompatible civilisations, which are wanted to give fulness and interest to life. The aim of eugenics is to represent each class or sect by its best specimens, causing them to contribute *more* than their proportion to the next generation; that done, to leave them to work out their common civilisation in their own way.

The course of procedure that lies within the functions of a learned and active society would be somewhat as follows :—

(1) Dissemination of a knowledge of the laws of heredity so far as they are surely known, and promotion of their further study. Few seem to be aware how greatly the knowledge of what may be termed the *actuarial* side of heredity has advanced in recent years. The *average* closeness of kinship in each degree now admits of exact definition and of being treated mathematically, like birth- and death-rates, and the other topics with which actuaries are concerned.

(2) Historical inquiry into the rates with which the various classes of society (classified according to civic usefulness) have contributed to the population at various times, in ancient and modern nations. There is strong reason for believing that national rise and decline are closely connected with this influence.

(3) Systematic collection of facts showing the circumstances in which large and thriving families have most frequently originated; in other words, the *conditions* of eugenics, on which much more information is wanted than is now to be had. It would be no great burden to a society, including many members who had eugenics at heart, to initiate and to preserve a large collection of such records for the use of statistical students. The committee charged with the task would have to consider very carefully the form of their circular and the persons entrusted to distribute it. They should ask only for as much useful information as could be easily, and would be readily, supplied by any member of the family appealed to. The point to be ascertained is the *status* of the two parents at the time of their marriage, whence its more or less eugenic character might have been predicted if the larger knowledge that we hope to obtain had then existed. The reasons would have to be shown why the children deserved to be entitled a "thriving" family. A manuscript collection such as this might hereafter develop into a "golden book" of thriving families. The act of systematically collecting records of thriving families would have the further advantage of familiarising the public with the fact that eugenics had at length become a subject of serious scientific study by an energetic society.

(4) Influences affecting marriage. The remarks of Lord Bacon in his essay on death may appropriately be quoted here. He says, with the view of minimising its terrors :—

"There is no passion in the mind of men so weak, but it mates and masters the fear of death. . . . Revenge triumphs over death; love slights it; honour aspireth to it; grief flyeth to it; fear pre-occupateth it."

Exactly the same kind of considerations apply to marriage. The passion of love seems so overpowering that it may be thought folly to try to direct its course. But plain facts do not confirm this view. Social influences of all kinds have immense power in the end, and they are very various. If unsuitable marriages from the eugenic point of view were banned socially, or even regarded with the unreasonable disfavour which some attach to cousin-marriages, very few would be made. The multitude of marriage restrictions that have proved prohibitive among uncivilised people would require a volume to describe.

(5) Persistence in setting forth the national importance of eugenics.

There are three stages to be passed through before eugenics can be widely practised. First, it must be made familiar as an academic question, until its exact importance has been understood and accepted as a fact. Secondly, it must be recognised as a subject the practical development of which is in near prospect, and requires serious consideration. Thirdly, it must be introduced into the national conscience, like a new religion. It has, indeed, strong claims to become an orthodox religious tenet of the future, for eugenics cooperate with the workings of nature by securing that humanity shall be represented by the fittest races. What nature does blindly, slowly and ruthlessly, man may do providently, quickly and kindly. As it lies within his power, so it becomes his duty to work in that direction, just as it is his duty to be charitable to those in misfortune. The improvement of our stock seems one of the highest objects that can be reasonably attempted. We are ignorant of the ultimate destinies of humanity, but feel perfectly sure that it is as noble a work to raise its level as it would be disgraceful to abase it. I see no impossibility in eugenics becoming a religious dogma among mankind, but its details must first be worked out sedulously in the study. Over-zeal leading to hasty action would do harm by holding out expectations of a near golden age which would certainly be falsified and cause the science to be discredited. The first and main point is to secure the general intellectual acceptance of eugenics as a hopeful and most important study. Then let its principles work into the heart of the nation, which will gradually give practical effect to them in ways that we may not wholly foresee.

[1] Abridged from a note read before the Sociological Society on May 16 by Dr. Francis Galton, F.R.S.